Litton ADVANCED CIRCUITRY

P. O. Box 2847, Commercial Station, Springfield, Mo. 65803 417 862-0751

January 26, 1982

Mr. Paul Meiburger
DNR Waste Management Program
P. O. Box 1368
Jefferson City, Missouri 65102

Mr. Meiburger:

Enclosed are the specifications for wells and monitoring program for Litton's on-site lagoon. Please review and contact me concerning any modifications that you feel necessary.

If you indeed feel that the April 9, 1982 date must be met, please expedite your review process as fast as possible since I feel the 3 weeks that you have allotted us is cutting it very close.

If you feel it is necessary that this report also be submitted to the EPA, please feel free to do so.

Very truly yours,

James K. Dow, P.E.
Facilities Manager
Litton ACD

JKD/cm

Enclosures: Specifications for Construction of
Ground-Water Monitoring Wells

Groundwater Monitoring Program

cc: Burt McCullough
DNR
1155 E. Cherokee
Springfield, Mo 65807

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7-75

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2/12/82

DEPARTMENT OF NATURAL RESOURCES
Division of Environmental Quality
Interoffice Communication

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KANSAS CITY MO.

To David Doyle EPA Subject O & M program

From Paul Meiburger Date Jan 82

I am planning to send comments by the 12th of February.

Any thoughts, please respond by then.

Thanks

Paul

David Doyle
US EPA Enforcement Branch
324 East Eleventh St
Kansas City, MO 64106

GROUNDWATER MONITORING PROGRAM

for

LITTON ADVANCED CIRCUITRY DIVISION

Springfield, Missouri

Submitted To:

Litton Advanced Circuitry Division

by

Jerome A. Westphal, Ph.D. P.E.
Consulting Hydrologist

December 22, 1981

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GROUNDWATER MONITORING PROGRAM

for

LITTON ADVANCED CIRCUITRY DIVISION
Springfield, Missouri

LOCATION

The ground-water monitoring program will be implemented at the facilities of Litton Advanced Circuitry Division, 4811 West Kearney, Springfield, Missouri. The impoundment for which the monitoring program is designed is located in the SE 1/4, SW 1/4, T29N, R22W (37° 14' 38" N, 93° 22' 33" W).

PURPOSE

Purpose of the monitoring program is to ensure prompt detection of any contamination of shallow groundwater in the Burlington-Keokuk Formation which may result as a consequence of seepage from a surface impoundment containing treated effluent from processes associated with the manufacture of electric circuit boards.

HYDROGEOLOGIC SETTING

According to Emmett, Skelton, Luckey, Miller, Thompson and Whitfield ("Water Resources and Geology of the Springfield Area, Mo.," Water Resources Report No. 34, Missouri Dept. of Natural Resources and U.S. Geological Survey, 1978), the major aquifer in the area of

Springfield includes the entire stratigraphic sequence from the Potosi Dolomite in the Upper Cambrian System to the Cotter Dolomite which is the uppermost member of the Ordovician System. This aquifer is more than 1000 feet thick and consists primarily of dolomite with minor sandstone units. Ground-water flow in this aquifer is confined by two relatively impermeable formations.

The Northview Formation is the upper confining layer for the major aquifer. It is comprised primarily of siltstones and shales. In the vicinity of Litton Advanced Circuitry Division, the Northview Formation is probably about 30 feet thick (Emmett, et. al., 1978, Figure 4). The Northview Formation retards flow from the overlying minor (shallow) aquifer to the major aquifer.

The minor (shallow) aquifer overlies the Northview Formation and is comprised of cherty limestones of Mississippian age. Well yields in this aquifer are generally 20 gallons per minute (gpm) or less. The uppermost member of the minor aquifer within a 10-mile radius of Litton Advanced Circuitry Division is the Burlington-Keokuk Limestone. This member consists of fine to coarsely crystalline limestone and ranges in thickness from about 155 feet to 270 feet. This formation is at or near the surface throughout most of western Greene County. It is deeply weathered and contains numerous sinkholes. In the vicinity of Litton Advanced Circuitry Division, the Burlington-Keokuk formation is overlain by approximately 15 feet of unconsolidated alluvium.

For the major aquifer, Emmett, et. al. (1978, Plate 3) show a well defined cone of depression which is centered on the City of Springfield. In this location, thickness of the Northview Formation

is probably about 20 feet (Emmett, et. al., 1978, Figure 4). The Litton Advanced Circuitry Division is apparently located somewhat outside the periphery of this cone on a broad, flat piezometric divide to the northwest. With existing data it is not possible to say with certainty which direction groundwater in the major aquifer flows beneath Litton Advanced Circuitry Division. However, from the interpretation of Emmett, et. al. (1978, Plate 3), it appears that flow would be to the northwest in the absence of the cone of depression.

According to Mr. Don Miller, Geologist with the Missouri Division of Geology and Land Survey, there were an insufficient number of water-level data from shallow wells to establish a piezometric map for the minor (shallow) aquifer in Springfield (personal communication). Consequently, it is not possible to establish the prevailing direction of ground-water movement in the shallow aquifer below Litton Advanced Circuitry Division. Because the Northview aquitard is 30 feet thick in this location and tends to get thicker to the north and northwest, and because Litton Advanced Circuitry Division is outside the periphery of the drawdown cone in the major aquifer, it is unlikely that drawdown in the major aquifer has a measureable effect on the configuration of the piezometric surface in the minor (shallow) aquifer at this location. It is likely that the prevailing hydraulic gradient in the minor aquifer will be generally northward and westward, the same as would occur in the major aquifer in the absence of ground-water pumpage from the City of Springfield.

Litton Advanced Circuitry Division is located approximately one mile north of the topographic divide which separates the Sac River Basin from the James River Basin. The impoundment of interest lies on

terrain which slopes gently to the north. U.S. Geological Survey 7.5 minute topographic quadrangle maps (Brookline, Ebenezer, Springfield and Willard) show ample evidence of collapsed sinkholes in every direction surrounding the impoundment. Surface drainage from the impoundment site is generally to the north and its precise direction is locally controlled by topography in the vicinity of collapsed sinkholes. The closest sinkhole to the impoundment is about 300 feet southeast, but on the opposite side of a low topographic divide. Two more are located east-northeast at distances of about 800 feet and 1300 feet respectively. A fourth is located about 1200 feet directly north of the northeast corner of the impoundment.

From inspection of the Springfield and Ebenezer 7.5 minute quadrangle sheets, there appears to be a concentration of collapsed sinkholes on a northeast trending line about 0.8 miles east of the Litton Advanced Circuitry Division. As may be observed on the Willard 7.5 minute quadrangle, there also seem to be an inordinate number of sinkholes extending from a position about 0.5 miles north of the impoundment to about 1.5 miles to the north and west of north. It is possible that these surface expressions of sinkholes and/or collapsed sinkholes indicate generally preferential flow paths for groundwater in the minor aquifer as it moves toward the Little Sac River.

MONITORING SYSTEM

Based on hydrogeologic and topographic evidence, it appears likely that groundwater in the minor (shallow) aquifer flows generally northward beneath Litton Advanced Circuitry Division. However, because the

extent of deep weathering of the Burlington-Keokuk Formation appears to be particularly severe a short distance to the east as well as to the north and northwest, it is difficult to predict exactly which flow path seepage from the impoundment might take as it leaves Litton Advance Circuitry Division property. For this reason, downgradient monitoring wells are located with respect to most probable directions of groundwater flow away from the impoundment.

As shown on Figure 1, well D1 is located to the east of the impoundment along the east property line of Litton Advanced Circuitry Division. This location was chosen with regard to the possibility of flow toward the sinkholes to the east. Well D2 is located north on a line between the impoundment and the closest sinkhole to the north. Well D3 is located so as to intercept flow from the impoundment to the northwest. To minimize risk of inadvertant aquifer contamination during well construction or contamination as a consequence of faulty well construction, downgradient wells were drilled at distances ranging from about 80 feet to 150 feet from the impoundment.

As shown on Figure 1, well U1 is an upgradient monitoring well. It is located about 750 feet south of the lagoon near the property boundary. This should be a sufficient distance to preclude the inducement of seepage from the impoundment toward the well during sampling.

Figure 2 shows general specifications for all four monitoring wells. Wells are to be a minimum of 6 inches in diameter and at least 150 feet deep. The upper 80 feet will be cased with blank PVC casing. The annular space outside the casing will be sealed with grout or other

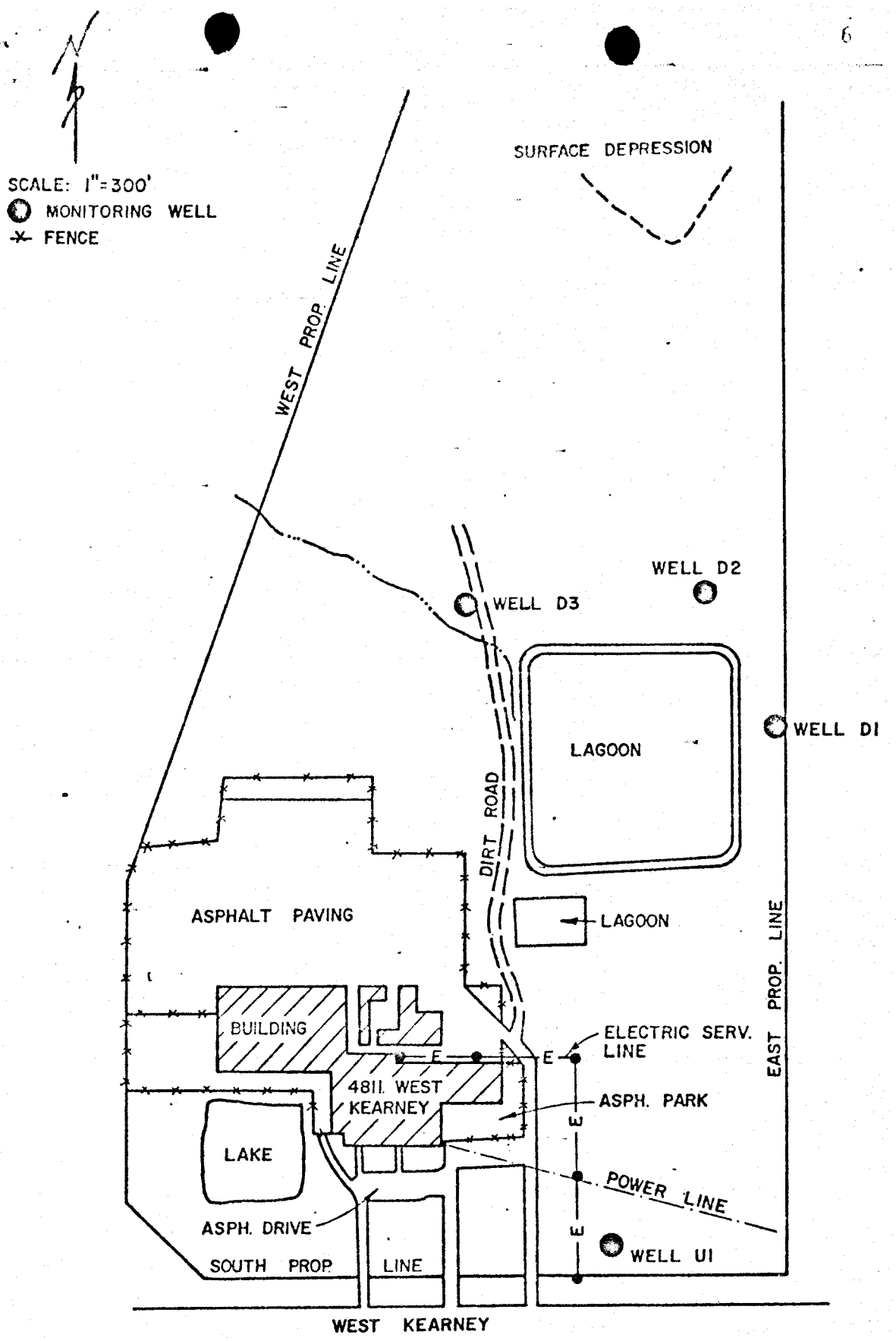
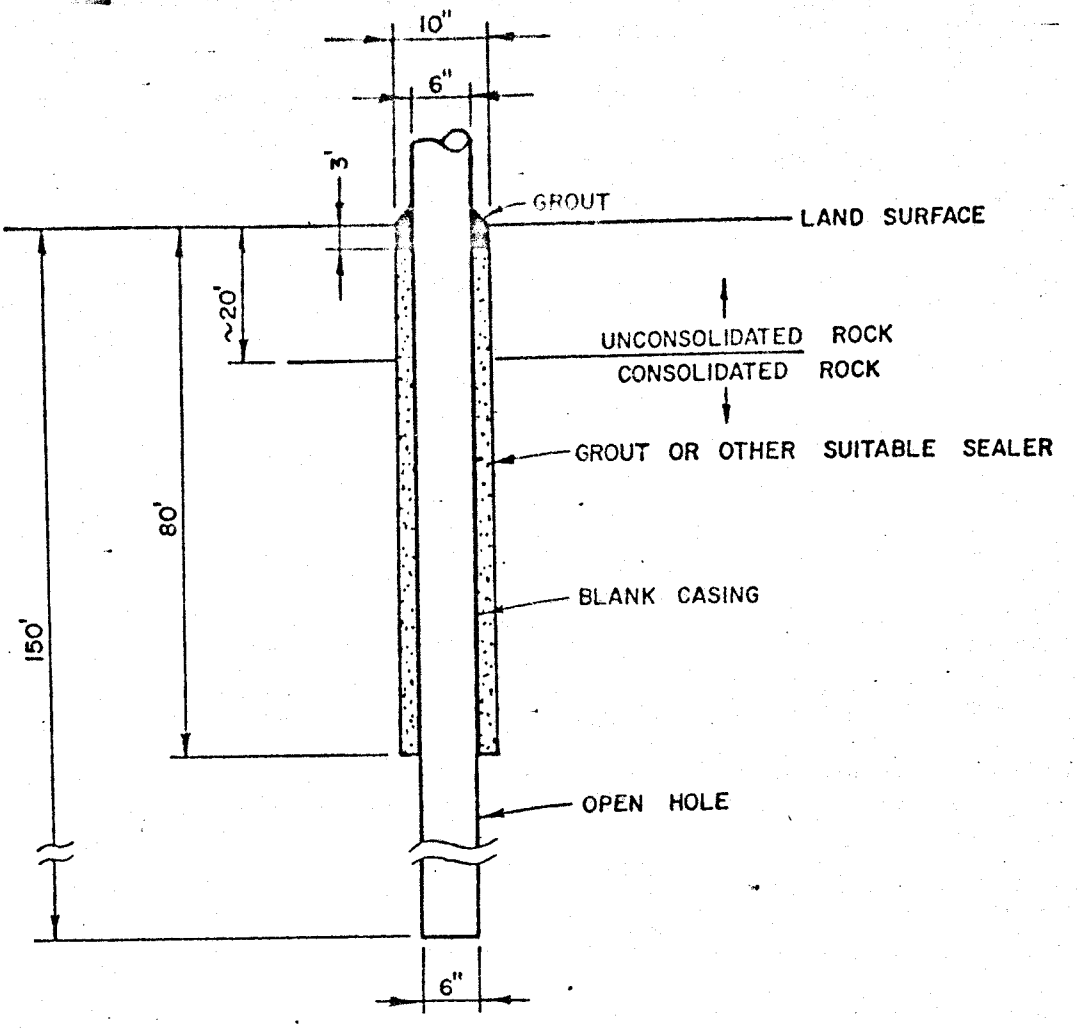
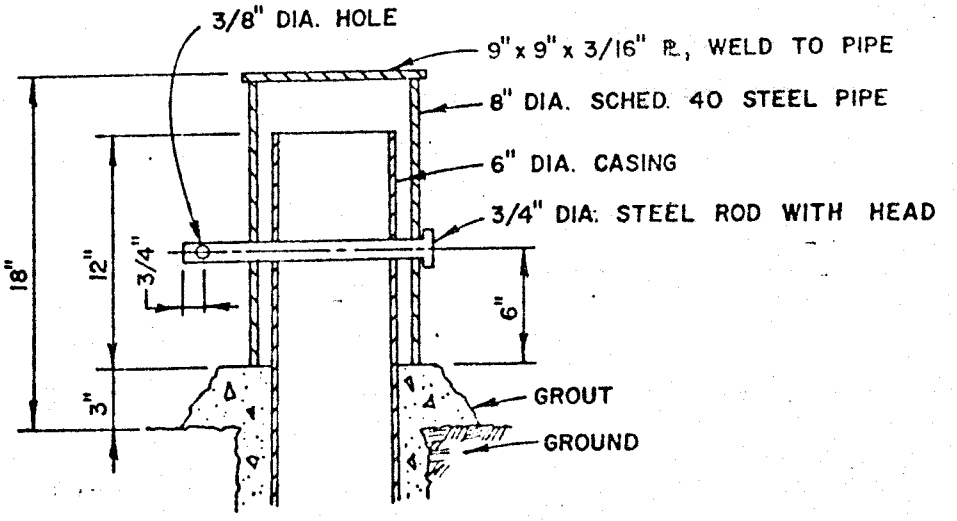


FIGURE 1: WELL LOCATION MAP



WELL



WELL COVER

FIGURE 2: WELL SPECIFICATIONS

suitable sealer to prevent vertical seepage along the casing. A lockable steel well cover will be installed to prevent inadvertant down-hole contamination and vandalism.

For purposes of water-level monitoring, a point on the top edge of the casing of each well will be marked with a notch or indelible marking. Elevation of these points will all be determined by surveying relative to a common, convenient datum.

SAMPLING AND ANALYSIS

Sample Collection: Prior to pumping any monitoring well, depth to water below the measuring point on the top edge of the casing will be measured and recorded noting well number, date, time and depth to water. Water levels will be measured using an electric sounder, steel tape with a chalk covered section to show wetting line, or a method of equivalent accuracy. Measurements will be read to the nearest 0.01 foot (or 1/8 inch if using inch calibrated tape).

After measuring depth to water, the well will be pumped for a sufficient time to evacuate a volume of water equal to that volume standing in the well prior to pumping. The pump will have plastic impellers and non-metallic fittings on the discharge line. Only after the standing water has been removed will samples be collected for analysis.

Samples will be collected in either polyethylene or glass containers. Samples to be analyzed for metals will have polypropelene caps without liners. Each container and cap will be thoroughly rinsed with water from the well immediately prior to filling the container. At each well,

temperature, pH and specific conductance will be measured on one of the unpreserved samples in the field prior to sealing. At each well, a minimum of one liter of water will be collected for determination of those inorganic non-metallic constituents which require no preservatives or fixatives. For determination of metallic ions, one-half liter will be collected, filtered on site and preserved with nitric acid. Separate samples will be collected for each of the other constituents requiring filtration and/or preservation. After sealing, each container will be marked with indelible ink to denote the well, date and time of collection. In addition, those samples having preservatives will be identified commensurate with the laboratory determinations for which they are intended.

Upon completion of sample collection at all four monitoring wells, samples will be delivered to Litton Advanced Circuitry Division laboratories where they will be stored according to recommendations contained in "Methods for Chemical Analysis of Water and Wastes" (EPA-600/4-75-020, March 1979), pending analysis.

Required Determinations: Water from monitoring wells will be analyzed for the presence of inorganic constituents as specified in the National Interim Primary Drinking Water Standards. These constituents and their limiting concentrations are shown in Table 1.

In addition to constituents listed in Table 1, analyses will be made to determine concentrations of iron, manganese and sodium. These parameters, together with chloride, phenols and sulfates will be used as a basis for comparison in the event of ground-water quality assessment is required.

TABLE 1

Constituents and Limiting Concentrations for Which Determinations Will be Made

Arsenic	50 µg/l	Selenium	10 µg/l
Barium	1000 µg/l	Silver	50 µg/l
Cadmium	30 µg/l	Zinc	100 µg/l
Chromium (Total)	500 µg/l	COD	10 mg/l
Copper	20 µg/l	Threshold Odor Number	3
Cyanide	10 µg/l	Linear Alkylate Sulfonates	1 mg/l
Fluoride	1200 µg/l	Chlorides	250 mg/l
Lead	50 µg/l	Sulfates	250 mg/l
Nickel	800 µg/l	Total Dissolved Solids	500 mg/l
Phenols	5 µg/l	Nitrate (as N)	10 mg/l

Determinations of pH, specific conductance, Total Organic Carbon and Total Organic Halogen will be used as a basis for identifying possible ground-water contamination. For each sample, at least four replicate measurements of each of these parameters will be made. The initial background condition will be established by calculating the arithmetic mean and variance for each parameter from the first year of replicated measurements. The mean and variance of each parameter as determined from measurements on samples from the upgradient well will constitute the baseline ground-water quality condition.

Evaluation of Water-level Changes: Water-level measurements in the monitoring wells will be evaluated after each sampling effort to verify that the upgradient well is beyond the influence of the impoundment and that downgradient wells are located appropriately to intercept groundwater which could be contaminated by seepage from the impoundment. If analysis of water levels indicates that monitoring wells are inappropriately placed, then the situation will be remedied in consultation with the appropriate DNR personnel.

Sampling Frequency: During the first year, determinations will be made for all constituents listed in Table 1 plus pH, specific conductance, Total Organic Carbon, Total Organic Halogen, iron, manganese and sodium in water samples collected quarterly from each monitoring well. After one year, determinations of chloride, iron, manganese, phenols, sodium and sulfate will be made for samples collected annually from each monitoring well. However, after the first year of monitoring, measurements of pH, specific conductance, Total Organic Carbon and Total

Organic Halogen will be made on water samples collected from all monitoring wells at six-month intervals.

Evaluation of Ground-water Quality Change: After the initial year of monitoring, at least four replicate determinations will be made for each parameter to be monitored as part of the semi-annual sampling program at each well. An arithmetic mean and variance will be computed from the replicate measurements and the mean will be compared with the mean for the baseline condition as established from the first year of data from the upgradient well, U1. The comparison will be for each parameter at each well. A comparison of a mean with the corresponding mean for the baseline condition will be made at the one-percent level of significance as determined from a one-tailed test using the criterion of student's t to determine if an increase (or decrease in the case of pH) may have occurred.

If, by the criterion of Student's t, there is a significant increase in any parameter (or pH decrease) in water from the upgradient well, the difference from background will be identified and included in the annual report to the Missouri Department of Natural Resources (DNR). In the event the mean for a parameter in water from a downgradient monitoring well differs (parameter increase or pH decrease) significantly from the baseline condition at the upgradient well (by the criterion of Student's t), additional samples will be collected from the well(s) where the change was noted. These samples will be split in two and reanalyzed for the parameter(s) which showed significant change. If the arithmetic mean of four replicated deforminations in each of the split samples fail to be significantly greater (less for pH) than the baseline mean, then no other

action will be taken. However, if the results verify a significant increase (pH decrease) from the baseline condition, DNR will be notified by writing within seven days of the assessment of change. Within 15 days of such a notification, Litton Advanced Circuitry Division will submit a ground-water quality assessment plan in accordance with 10 CSR25-7.011 (10)(D)4., subparagraphs B and C.

RECORD KEEPING AND REPORTING

Litton Advanced Circuitry Division will maintain records of all water quality determinations and water-level measurements taken as a part of this monitoring program for the active life of the facility and for the post closure period. During the first year of monitoring, concentrations of Total Organic Carbon and Total Organic Halogen and values of pH and specific conductance will be submitted to DNR in writing within 15 days of the end of the quarterly reporting period. In addition, if concentrations or values of any parameter listed in Table 1 exceed the tabulated value, the parameter, its value or concentration and the monitoring well where it was found will be contained in the quarterly report.

An annual report will be submitted to DNR which contains results of the previous year of monitoring at each well. It will contain results of the semi-annual determinations of pH, specific conductance, Total Organic Carbon and Total Organic Halogen. If there are significant differences (parameter increase, pH decrease) between the mean of the four replicate measurements of any parameter in water from the upgradient well

and the previously determined baseline condition, this evaluation will also be contained in the annual report. Finally, if it is determined from evaluation of water-level data that the requirements for representative sampling in upgradient and downgradient directions are not being fulfilled, this fact along with the proposed corrective action will be set forth in the annual report to DNR.

SPECIFICATIONS FOR CONSTRUCTION OF

GROUND-WATER MONITORING WELLS

FOR

LITTON ADVANCED CIRCUITRY DIVISION

1. GENERAL.

1.1 Scope of Work. The work to be done by the Contractor consists of drilling and developing a total of four wells on the property of Litton Advanced Circuitry, 4811 West Kearney, Springfield, Missouri. The general site locations are shown on exhibit A, attached. Specific hole locations are to be set in the field by the Owner's representative. The Contractor shall furnish all labor, material, transportation, tools, supplies, plans, equipment and appurtenances, unless hereinafter specifically excepted, necessary for the complete and satisfactory construction, cleaning and development of the proposed monitoring wells. The Contractor shall furnish all labor and equipment required for collection of cuttings and other related work described herein.

1.2 Permits, Certificates, Laws and Ordinances. The Contractor shall, at his own expense, procure all permits, certificates and licenses required of him by law for the execution of his work. He shall comply with all Federal, State, or local laws, ordinances or rules and regulations relating to performance of the work.

1.3 Ownership of Well Sites. The monitoring wells are to be constructed on property owned by Litton Advanced Circuitry in the vicinity of 4811 West Kearney, Springfield, Missouri.

1.4 Local Conditions. Lithologic and well production information for wells in the vicinity of the project site is severely limited. The Contractor is encouraged to review copies of drillers' reports for wells in the general vicinity of the project site. These reports are on file with the Missouri Division of Geological Survey in Rolla, Missouri. In addition, the area is known to be karstic with a known sinkhole located several hundred feet north of the project site. The Contractor is encouraged to consult with professional personnel of the geology/geologic engineering staff of the Missouri Division of Geological Survey or U.S. Geological Survey, Water Resources Division, pertaining to special problems encountered while drilling wells in karst terrain.

1.5 Boundaries of Work. The Owner shall provide land or rights-of-way for the work specified herein and make suitable provisions for ingress and egress. The Contractor shall not enter on or occupy with men, tools, equipment or materials any property without consent of the Owner and shall confine his activities to the drilling sites designated by the Owner.

1.6 Protection of Monitoring Well Sites. Except as otherwise provided herein, the Contractor shall protect all structures, walks, pipelines, trees, etc. during the process of his work. The Contractor shall remove from the site and dispose of all cuttings, debris and unused materials. Upon completion of the work, the Contractor shall restore the site as nearly as is possible to its original condition, including the replacement, at the Contractor's sole expense, of any facility which has been damaged beyond possible restoration to its original condition or destroyed. Water pumped from each well shall be conducted away from the well and disposed of in a manner which will not create a nuisance or damage property. Any

permits which may be required by the State of Missouri or by local ordinance for the discharge of water during well drilling, development, or testing shall be provided by the Contractor.

1.7 General Description of Wells. The upper 80 feet of the monitoring wells shall be cased with PVC 1120 or PVC 1220 Schedule 80 or Class 200 blank casing with a nominal 6-inch diameter. The annualar space between the casing and drill hole shall be grouted or otherwise filled with an approved impermeable filler. The bottom 70 feet of each well will be open hole with a nominal diameter of 6 inches.

1.8 Facilities or Material to be Furnished by the Owner. No materials or utilities will be furnished by the Owner to the Contractor at the site of work. The Owner's representative will designate the exact well location in the field at each site.

1.9 Competent Workmen. The Contractor shall employ only competent workmen for the execution of his work. All work shall be performed under the direct supervision of an experienced well driller to the satisfaction of the Owner's designated representative on site.

1.10 Definitions. The following definitions apply to these specifications:

Owner - Litton Advanced Circuitry

Owner's Representative - A registered professional engineer in the employ of Litton Advanced Circuitry or a Consultant hired by Litton Advanced Circuitry to oversee and direct the well drilling and development.

Consultant - A registered professional engineer or geologist with special competence in ground-water hydrology retained by Litton Advanced Circuitry for the purpose of overseeing construction and development of the monitoring wells.

Contractor - The successful bidder for the work to be done under these specifications.

2. MATERIALS

2.1 Well Casing. The well casing shall be 6-inch diameter PVC 1120 or PVC 1220 Schedule 80 or Class 200, as supplied by Timco Manufacturing, Inc., 851 Fifteenth Street, Prairie Du Sac, WI 53578, or approved equal.

2.2 Casing Joints. The casing joints shall be flush, solvent welded with pins such as supplied by Timco Manufacturing or the approved equal.

2.3 Grout. Grout shall consist of a mixture of not more than 6 gallons of water and one 94 pound sack of cement. Baroid Shure Jell or its approved equivalent may be substituted for grout at depths of 3 feet or more below the ground surface.

2.4 Well Cover and Bracket. The well cover and bracket shall be steel.

2.5 Alternate Materials. Alternate materials which the Contractor may be accustomed to using may be substituted by the Contractor for those specified herein provided prior approval is obtained from the Owner or Owner's Representative. The casing must be corrosion resistant and may not be mild steel or fiberglass. Prior to approval by the Owner or Owner's Representative, the Contractor may be required to provide specifications and samples of the proposed alternative materials.

3. DESCRIPTION OF WORK.

3.1 General. One well is to be drilled at each of four sites (a total of four wells) in the vicinity of the wastewater treatment lagoon which is located about 500 feet northeast of the main office building of Litton Advanced Circuitry Division at 4811 West Kearney, Springfield, Missouri. Each well will be approximately 150 feet deep. Approximate well locations

are shown on Figure 1. One well, designated Well U1, will be located near the property line about 750 feet south of the lagoon. One well, designated Well D1, will be located east of the lagoon and as close as is feasible to the property line. Another well, designated Well D2, will be located approximately 100 feet north of the northeast corner of the lagoon. The fourth well, designated Well D3, will be located about 150 feet northwest of the northwest corner of the lagoon.

3.2 Method of Drilling. The method of drilling shall be conventional rotary or other rotary or rotary/percussion method which is acceptable to the Owner or the Owner's Representative. The cable tool method is not acceptable for this project.

3.3 Hole Specifications: A schematic drawing of a completed well is shown on Figure 2.

3.3.1 The first 80 feet below land surface shall be at least 10-inches in diameter and large enough to install casing with a nominal diameter of 6 inches.

3.3.2 The bottom 70 feet of the hole shall remain uncased and shall have a nominal diameter of 6-inches. The diameter of this part of the well shall not be less than 5 inches.

3.3.3 The Contractor shall, upon completion of the well, demonstrate that the well is sufficiently straight and plumb to allow a 4-inch diameter submersible pump and 4 feet in length to be lowered to the bottom of the well.

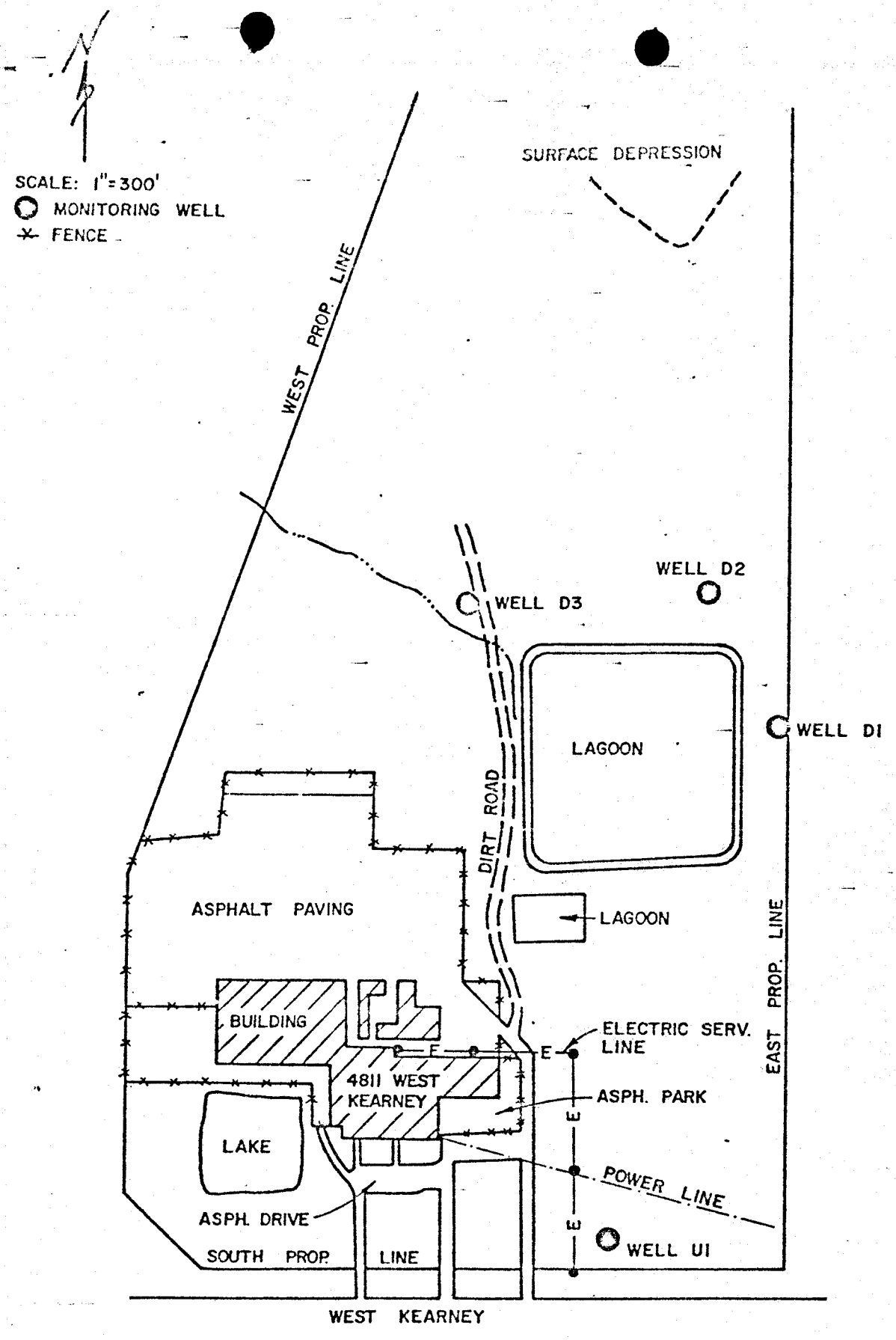
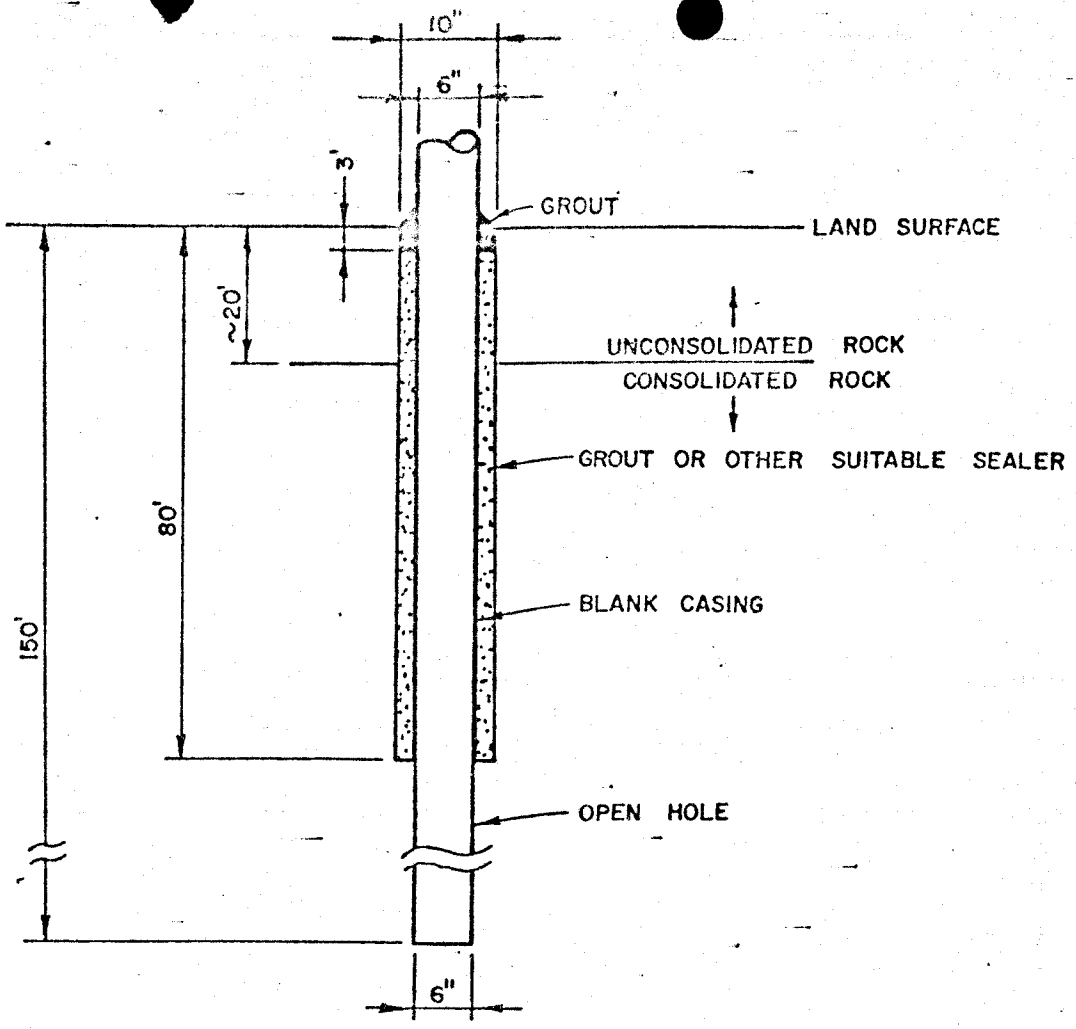
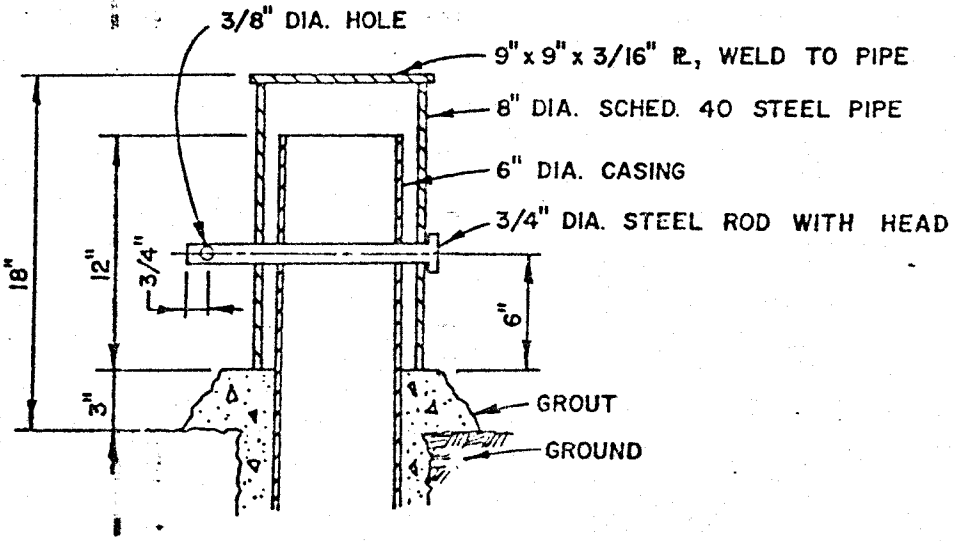


FIGURE 1: WELL LOCATION MAP



WELL



WELL COVER

FIGURE 2: WELL SPECIFICATIONS

3.3.4 Construction procedures:

a. Cuttings shall be collected at 5-foot intervals or at each formation change, whichever is less. Cuttings should not be washed. They are to be collected in clean and durable containers such as 1-pint ice cream or cottage cheese containers. Each container shall have the well designation and the depth from which the cuttings were collected marked clearly with indelible ink. Cuttings from each hole shall be delivered to the Owner or Owner's Representative at their mutual convenience.

b. The annular space between the casing and hole in the upper 80 ft. of the well shall be sealed with grout from the bottom to the surface by forcing grout from the bottom of the casing out and upward through the annular space. Alternative methods or materials may be used, subject to prior approval by the Owner or the Owner's Representative, provided an equivalent seal can be obtained between the casing and hole in the upper 80 feet. In any case, the uppermost 3 feet of annular space must be sealed with grout.

3.3.5 The Contractor shall develop the well by such methods as will effectively extract from the water-bearing formation the drilling fluid and the maximum practicable quantity of residual cuttings and fine grained materials. Compressed air, surge plungers, high velocity jetting equipment and/or pumps may be used for the development. Development shall be done in such a manner that it does not cause undue settlement or disturbance of strata above the water-bearing formation. Development shall not compromise

the integrity of the seal in the annular space around the casing. Development shall continue until such time as the Owner or Owner's Representative determines that foreign matter has been removed from the well and the well has sufficient capacity to sustain the pumping rate necessary for water sampling.

3.4 Alternate Construction Methods. Construction methods described herein are to be used by the Contractor to develop a bid for the work and for actual construction. Alternate construction methods which may be proposed by the contractor must be approved by the Owner or Owner's Representative prior to implementation. The Owner or Owner's Representative may order the Contractor to use alternate construction methods.

3.5 Well Cover. The Contractor shall furnish and install a well cover at each completed well. Specifications for the well cover are shown on Figure 2.

4. PAYMENT.

4.1 Labor and Equipment. The Contractor shall propose the rate of payment for the following:

a. Drilling rig, equipment and crew, per day. State any limitations on the maximum or minimum number of days per week or month.

b. Drilling rig and equipment on standby (idle at site without crew), per day, except Saturdays, Sundays and holidays.

4.2 Materials. Materials shall be paid for on the basis of actual cost to the Contractor (including shipping) plus a percentage markup to cover

overhead costs. The Contractor shall propose the percentage of actual cost to be added as markup.

4.4 Statements. Monthly statements shall be submitted to the Owner. The statements shall be thoroughly itemized to facilitate verification by the owner before payment.

SPECIFICATIONS FOR CONSTRUCTION OF

GROUND-WATER MONITORING WELLS

FOR

LITTON ADVANCED CIRCUITRY DIVISION

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permits which may be required by the State of Missouri or by local ordinance for the discharge of water during well drilling, development, or testing shall be provided by the Contractor.

1.7 General Description of Wells. The upper 80 feet of the monitoring wells shall be cased with PVC 1120 or PVC 1220 Schedule 80 or Class 200 blank casing with a nominal 6-inch diameter. The annualar space between the casing and drill hole shall be grouted or otherwise filled with an approved impermeable filler. The bottom 70 feet of each well will be open hole with a nominal diameter of 6 inches.

1.8 Facilities or Material to be Furnished by the Owner. No materials or utilities will be furnished by the Owner to the Contractor at the site of work. The Owner's representative will designate the exact well location in the field at each site.

1.9 Competent Workmen. The Contractor shall employ only competent workmen for the execution of his work. All work shall be performed under the direct supervision of an experienced well driller to the satisfaction of the Owner's designated representative on site.

1.10 Definitions. The following definitions apply to these specifications:

Owner - Litton Advanced Circuitry

Owner's Representative - A registered professional engineer in the employ of Litton Advanced Circuitry or a Consultant hired by Litton Advanced Circuitry to oversee and direct the well drilling and development.

Consultant - A registered professional engineer or geologist with special competence in ground-water hydrology retained by Litton Advanced Circuitry for the purpose of overseeing construction and development of the monitoring wells.

Contractor - The successful bidder for the work to be done under these specifications.

2. MATERIALS

2.1 Well Casing. The well casing shall be 6-inch diameter PVC 1120 or PVC 1220 Schedule 80 or Class 200, as supplied by Timco Manufacturing, Inc., 851 Fifteenth Street, Prairie Du Sac, WI 53578, or approved equal.

2.2 Casing Joints. The casing joints shall be flush, solvent welded with pins such as supplied by Timco Manufacturing or the approved equal.

2.3 Grout. Grout shall consist of a mixture of not more than 6 gallons of water and one 94 pound sack of cement. Baroid Shure Jell or its approved equivalent may be substituted for grout at depths of 3 feet or more below the ground surface.

2.4 Well Cover and Bracket. The well cover and bracket shall be steel.

2.5 Alternate Materials. Alternate materials which the Contractor may be accustomed to using may be substituted by the Contractor for those specified herein provided prior approval is obtained from the Owner or Owner's Representative. The casing must be corrosion resistant and may not be mild steel or fiberglass. Prior to approval by the Owner or Owner's Representative, the Contractor may be required to provide specifications and samples of the proposed alternative materials.

3. DESCRIPTION OF WORK.

3.1 General. One well is to be drilled at each of four sites (a total of four wells) in the vicinity of the wastewater treatment lagoon which is located about 500 feet northeast of the main office building of Litton Advanced Circuitry Division at 4811 West Kearney, Springfield, Missouri. Each well will be approximately 150 feet deep. Approximate well locations

are shown on Figure 1. One well, designated Well U1, will be located near the property line about 750 feet south of the lagoon. One well, designated Well D1, will be located east of the lagoon and as close as is feasible to the property line. Another well, designated Well D2, will be located approximately 100 feet north of the northeast corner of the lagoon. The fourth well, designated Well D3, will be located about 150 feet northwest of the northwest corner of the lagoon.

3.2 Method of Drilling. The method of drilling shall be conventional rotary or other rotary or rotary/percussion method which is acceptable to the Owner or the Owner's Representative. The cable tool method is not acceptable for this project.

3.3 Hole Specifications: A schematic drawing of a completed well is shown on Figure 2.

3.3.1 The first 80 feet below land surface shall be at least 10-inches in diameter and large enough to install casing with a nominal diameter of 6 inches.

3.3.2 The bottom 70 feet of the hole shall remain uncased and shall have a nominal diameter of 6-inches. The diameter of this part of the well shall not be less than 5 inches.

3.3.3 The Contractor shall, upon completion of the well, demonstrate that the well is sufficiently straight and plumb to allow a 4-inch diameter submersible pump and 4 feet in length to be lowered to the bottom of the well.

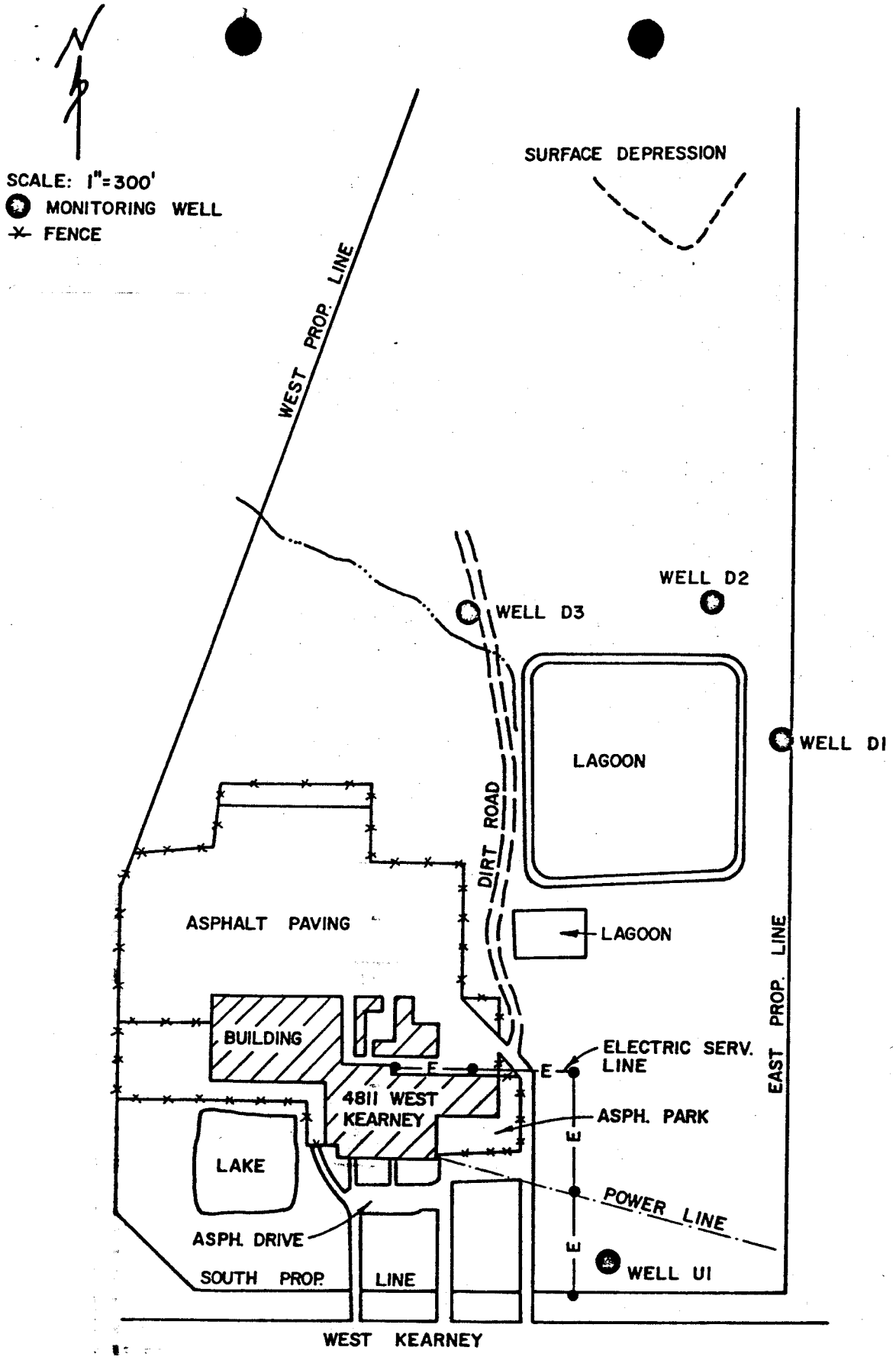
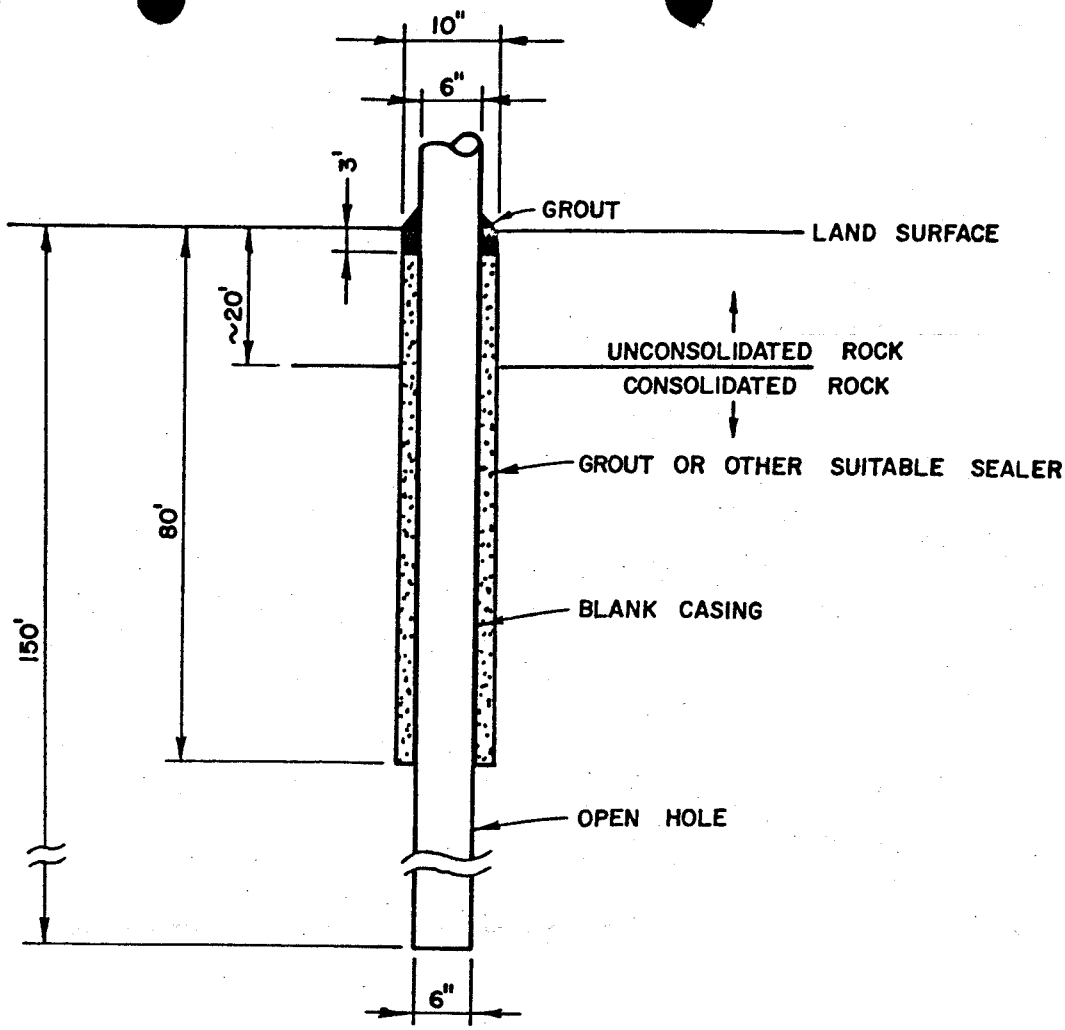
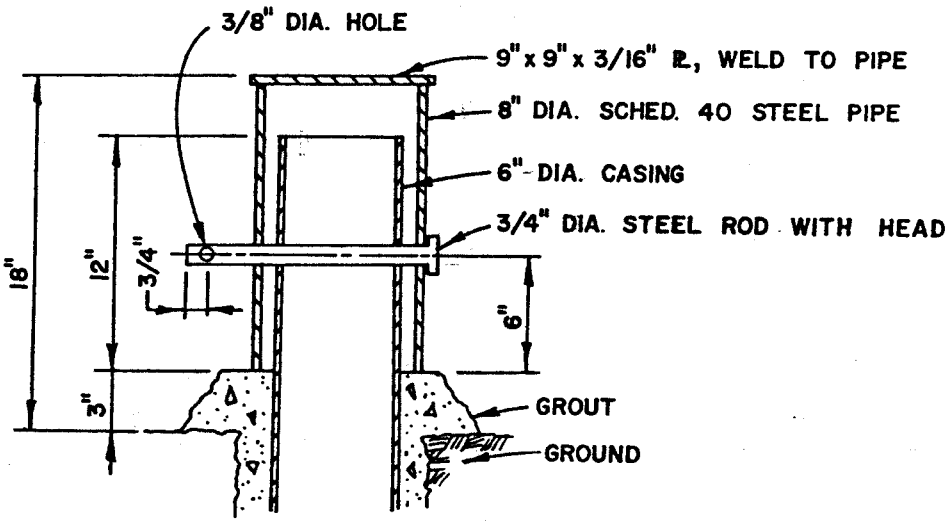


FIGURE 1: WELL LOCATION MAP



WELL



WELL COVER

FIGURE 2: WELL SPECIFICATIONS

3.3.4 Construction procedures:

a. Cuttings shall be collected at 5-foot intervals or at each formation change, whichever is less. Cuttings should not be washed. They are to be collected in clean and durable containers such as 1-pint ice cream or cottage cheese containers. Each container shall have the well designation and the depth from which the cuttings were collected marked clearly with indelible ink. Cuttings from each hole shall be delivered to the Owner or Owner's Representative at their mutual convenience.

b. The annular space between the casing and hole in the upper 80 ft. of the well shall be sealed with grout from the bottom to the surface by forcing grout from the bottom of the casing out and upward through the annular space. Alternative methods or materials may be used, subject to prior approval by the Owner or the Owner's Representative, provided an equivalent seal can be obtained between the casing and hole in the upper 80 feet. In any case, the uppermost 3 feet of annular space must be sealed with grout.

3.3.5 The Contractor shall develop the well by such methods as will effectively extract from the water-bearing formation the drilling fluid and the maximum practicable quantity of residual cuttings and fine-grained materials. Compressed air, surge plungers, high velocity jetting equipment and/or pumps may be used for the development. Development shall be done in such a manner that it does not cause undue settlement or disturbance of strata above the water-bearing formation. Development shall not compromise

the integrity of the seal in the annular space around the casing. Development shall continue until such time as the Owner or Owner's Representative determines that foreign matter has been removed from the well and the well has sufficient capacity to sustain the pumping rate necessary for water sampling.

3.4 Alternate Construction Methods. Construction methods described herein are to be used by the Contractor to develop a bid for the work and for actual construction. Alternate construction methods which may be proposed by the contractor must be approved by the Owner or Owner's Representative prior to implementation. The Owner or Owner's Representative may order the Contractor to use alternate construction methods.

3.5 Well Cover. The Contractor shall furnish and install a well cover at each completed well. Specifications for the well cover are shown on Figure 2.

4. PAYMENT.

4.1 Labor and Equipment. The Contractor shall propose the rate of payment for the following:

a. Drilling rig, equipment and crew, per day. State any limitations on the maximum or minimum number of days per week or month.

b. Drilling rig and equipment on standby (idle at site without crew), per day, except Saturdays, Sundays and holidays.

4.2 Materials. Materials shall be paid for on the basis of actual cost to the Contractor (including shipping) plus a percentage markup to cover

overhead costs. The Contractor shall propose the percentage of actual cost to be added as markup.

4.4 Statements. Monthly statements shall be submitted to the Owner. The statements shall be thoroughly itemized to facilitate verification by the owner before payment.